vance of their publication in the *Boletin Mensual;* an abstract translated into English measures is here given in continuation of the similar tables published in the MONTHLY WEATHER REVIEW during 1896. The barometric means have not been reduced to standard gravity, but this correction will be given at some future date when the pressures are published on our Chart IV.

Mexican data for December, 1897.

Stations.	Altitude.	Mean barometer.	Temperature.			Relative humidity.	Precipitation.	Prevailing direction.	
			Max.	Min.	Mean.			Wind.	Cloud.
	Feet.	*Inch.*	° *F.*	° *F.*	° *F.*	%	*Inch.*		
Arteaga (Coahuila)	.....	.....	83.3	29.7	59.5	.....	0.00	.....	.....
Barousse (Coahuila)	5,414	.....	77.7	32.0	58.3	.....	0.00	.....	.....
Colima (Sem.)	1,656	.....	.....	.....	75.7	.....	.....	.....	.....
Durango	6,241	24.04	78.8	39.2	54.9	51	0.28	sw.	sw.
Leon	5,934	24.32	75.4	27.7	57.9	51	T.	se.	wsw.
Linares (Nuevo Leon)	1,198	29.00	83.3	35.6	56.1	70	0.37	.....	.....
Magdalena (Sonora)	4,948	.....	.....	.....	55.4	.....	0.03	ne.	n.
Merida (Yucatan)	50	30.01	94.5	54.5	74.3	72	0.23	ne.	n.
Mexico (Obs. Cent.)	7,472	23.10	70.7	35.6	55.8	58	0.03	e.	ne.
Monterey	1,626	28.41	84.2	37.2	55.8	63	0.23	e.	ne.
Morelia (Seminario)	6,401	24.40	76.3	39.2	59.2	63	0.12	sw.	w.
Oaxaca	5,164	25.11	82.4	40.1	74.3	60	0.49	w.	ne.
Parros (Coahuila)	3,986	.....	74.8	42.8	59.2	.....	0.71	.....	.....
Puebla (Col. Cat.)	7,112	23.52	75.6	30.7	58.8	52	0.08	ne.	.....
Rosario (Sinaloa)	.....	.....	93.0	21.0	60.3	.....	0.04	sw.	s.
Saltillo (Col. S. Juan)	5,399	24.91	77.2	32.0	55.6	62	T.	s.	n.
San Luis Potosi	6,202	24.30	73.4	35.1	56.8	57	0.06	ne.	w.
Silao (Guanajuato)	6,063	24.32	72.0	39.0	60.8	58	T.	w., sw.	w.
Torreon (Coahuila)	3,720	.....	78.4	37.4	60.8	.....	0.00	.....	.....
Trejo (Guanajuato)	.....	.....	63.5	.....	.....	.....	0.00	w.	.....
Tuxtla (Gutierrez)	1,864	28.06	91.4	51.8	72.9	71	0.00	n.	sse.
Zapotlan (Seminario)	5,078	.....	78.3	44.2	55.2	55	0.00	sse.	sw.

THE ELECTRIC STORMS OF CALIFORNIA.

By J. A. BARWICK, Observer Weather Bureau (dated Sacramento, December 18, 1897).

The electric storms of California are not local to any one portion of the State over another; thunderstorms are observed as occurring on the same day over 800 miles apart, viz, at Picacho, San Diego County, in the southeastern portion of the State, and at Yreka, Siskiyou County, in the northern portion of the State.

During the thunderstorm of August 19, 1896, electric displays were observed in the following counties, beginning in the north and going south, viz, Siskiyou, Modoc, Lassen, Tehama, Sonoma, Alameda, Santa Clara, Mono, San Bernardino, and San Diego counties. Siskiyou and San Diego counties are nearly 800 miles apart.

The greater number of thunderstorms in summer (June, July, and August) are confined mostly to the counties of the Coast Range and the Sierra Nevada range of mountains. Scarcely a day passes in summer but what the tops of thunder-head clouds, such as cumulo-stratus and cumulo-nimbus, may be observed from Sacramento over the Sierra Nevada range of mountains, especially in the northeastern and eastern portions of the horizon. The greater number of these storms are noted in July and August, during and at the closing of a hot spell in the Sacramento and San Joaquin valleys. As the hot and moist-laden air rises it strikes the upper southwesterly current of air and is wafted over the Sierra Nevada Mountains, where the moisture is rapidly condensed, forming these thunder-head clouds. It is among such clouds as these that so much sheet lightning is observed and reported by observers in the foothill and valley towns.

The greater number of these storms are reported as occurring during the months of May, June, July, August, and September; the hotter the weather in summer the greater are the number of such storms observed and reported. The records for 1896 and 1897 show a greater number recorded. Possibly this is due partly to an increased number of observers and to more accurate records of those storms than during previous years, when a much smaller number was reported.

The tabulated data herewith gives a record of all electric storms reported by the voluntary observers throughout the State from September, 1891, to October, 1897, inclusive.

Total number of thunderstorms recorded as having occurred in the State of California from September, 1891, to October, 1897.

Year.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	Total.	Monthly averages.
January	.....	0	1	6	5	7	6	25	4
February	.....	2	0	0	1	4	8	15	3
March	.....	0	4	2	3	3	7	28	5
April	.....	3	2	4	5	9	5	28	5
May	.....	4	7	6	4	13	10	44	7
June	.....	6	0	9	5	11	15	46	8
July	.....	8	8	12	3	25	4	60	10
August	.....	2	0	15	6	18	17	58	10
September	2	8	6	2	7	12	14	51	7
October	1	9	0	1	10	4	5	30	4
November	0	7	3	1	0	0	.....	11	2
December	2	1	6	4	3	1	.....	17	3
Total	*5	59	37	62	53	107	†91	413	88

NOTE.—Total and average for September and October are for seven years. *For four months. †For ten months.

It is true that during cool summers there are much fewer electrical displays than during hot summers with long-continued spells of excessive heat. Had I the time I should be pleased to prepare a chart showing the counties where electric displays were recorded from 1891 to 1897. By such means the points in the State where the greatest number of electric displays are observed would be plainly indicated. No doubt, if our summers in California were as wet and stormy as in the States east of the Rocky Mountains, our record of magnificent electric displays would be equal to those of the East.

In March, 1881, when I took charge of this station, it was reported to me by numerous "oldest inhabitants" that there was no such thing in this State as thunder and lightning. As the same idea had been reported to people in the East, inquiry was made of this office asking if such were the fact. Our records for this station were searched and an article prepared and published in the Monthly Bulletin of the California Weather Service for June, 1893, covering the years from July 1, 1877, to May 17, 1893.

The following are descriptions by the voluntary observers of electric storms of severity that were recorded by them:

September 5, 1891.—Telephones burned out at Pleasanton and Livermore, Alameda County.

June 8, 1892.—Oleta, Amador County, lightning struck a pine tree on the roadside near the village, killing 18 sheep out of a passing band.

September 25, 1892.—Milton, Calaveras County, lightning quite vivid, and was a remarkable and unusual display for this part of the country. Nevada City, Nevada County, September 25, 1892, was the severest and longest ever known to the oldest resident of this section. San Jose, Santa Clara County, the storm of the 25th was the greatest electrical display ever seen by the residents of this city; many young people saw more lightning and heard more thunder than they had ever before observed. Willows, Glenn County, on the evening of the 25th the electric storm in the Sierra Nevada Mountains showed lightning of every kind, visible from this town, from northeast along the entire horizon to the southeast; sometimes for half an hour the lightning was continuous; only a few clouds were visible from this point.

May 12, 1893.—A very sharp thunderstorm passed over Pasadena, Los Angeles County, giving a dozen blinding flashes of lightning; one flash struck the earth within 1,000 feet of the observer and was followed by a tremendous crash. Colegrove, Los Angeles County, on the 12th lightning vivid, several wavy streaks observed in the distant east, which extended horizontally through the clouds at least 15 to 20 miles in length.

May 17, 1893.—Anderson, Shasta County, this storm was the worst that has ever passed over this section; the center appeared to be over Redding, doing some damage by striking the Presbyterian church spire and tearing it away; some two hundred yards away from the church it struck the tree on which the Ruggles brothers were hanged. There were three movements of clouds, one passing along the Coast Range northeast, one along the foothills from the east to the northwest, and one in the center moving northward, all forming over the town of Redding; balls of electricity dropped off the electric wires. It was a grand display, but without much damage.

November 24, 1893.—Heavy thunderstorm at Hydesville, Humboldt County, the lightning struck a tree about 5 miles east of this town and set it on fire.

December 27, 1893.—Severe thunderstorm passed over Pasadena, Los Angeles County, one bolt of lightning striking a stable and destroying it, along with 75 tons of hay.

July 9, 1894.—At Gardnerville, Alpine County, lightning struck a barn, killing one horse and stunning several persons, and the building was set on fire by the lightning.

In his review for July, 1896, Mr. Barwick says:

There were heavy thunder and lightning storms over all the mountain regions of the State, with numerous cloudbursts, and, singular to relate, these cloudbursts appear to have occurred on the day of the occurrence of the maximum temperature over the greater portion of the interior of the State, namely, on the 9th of July.

Thunder and lightning were reported from several places along the coast, which are rather unusual occurrences. Generally speaking the cloudbursts and thunder and lightning storms occurred during the prevalence of the long and severe hot spell of July, from the 1st to the 25th. From all accounts this was the most disastrous hot spell to the interior valleys of California since the unprecedented hot wave of June and July, 1859, when horses died in great numbers, and even birds and wild animals succumbed to the fierce rays of the sun, and several persons were reported to have died from the effects of the hot wave.

NOTES BY THE EDITOR.

MECHANICAL DETERMINATION OF RESULTANT WIND.

At the December meeting of the Meteorological Society of France, M. L. Besson exhibited an instrument that gives, mechanically, the mean direction and force of the wind, and thus dispenses with the calculations that are necessary in the application of Lambert's method.

This instrument is composed essentially of a vertical wheel, moving easily around its axis, and having near its circumference small equidistant projecting horizontal pins or rods to the number, for example, of sixteen, corresponding to the sixteen principal directions of the wind. If we hang on each of these pins a weight proportional to the movement of the corresponding wind, the wheel will take a certain position of equilibrium, such that the lowest point of the wheel indicates exactly the resultant direction of the wind movement. The apparatus can be made more complete by adding a balanced alidade, which is itself provided at one end with a small pin similar to those of the principal wheel. When the direction of the resultant has been found we set the alidade to the opposite direction, and suspend from it certain weights, until we obtain neutral equilibrium. By giving to the alidade a convenient length we can thus, directly, measure the relative value of the resultant, that is to say, the degree of variability of the wind during the period under consideration.* The model actually presented to the society shows the simplest form that can be given to this instrument. It is intended for the determination of the mean direction of the wind during any one day, from hourly or trihourly observations. The weights that are employed are counters of equal mass, pierced through their centers; each of these represents one observation. One may agree to call the wind variable if twelve counters suspended on the pin opposite to the resultant suffice to bring the system into neutral equilibrium.

These mechanical devices in the hands of skillful manipulators will scarcely do their work more quickly, and will rarely do it as accurately as can be done by the skillful computor. The simple form used by the Weather Bureau for the computation of resultant winds, when used in connection with Crelle's multiplication table, is probably better than the mechanical device, and yet there are many who would prefer the latter as avoiding the ordinary errors of computation.

There are many other mechanical devices that may be advantageously introduced into meteorological computations. Professor Mascart, who presided at the meeting of the Meteorological Society, suggested that the same apparatus could also be applied to the solution of questions regarding the composition of colors, thereby replacing the whirling disk of Sir Isaac Newton, and the color-triangle of Lord Rayleigh. In fact, the apparatus can be used for showing quickly the resultant of any complex system of forces, provided they all act at one point of application and do not introduce moments of rotation.

The apparatus of Besson, as above described, can apparently be simplified by omitting the alidade and substituting the following construction. The resultant direction is usually desired to within two or three degrees. In order to secure this degree of accuracy we divide the circumference into 128 equal parts, each representing $2\frac{13}{16}$ degrees, and insert corresponding pins, giving each a letter or number from *north* around the entire circle consecutively. On a wheel 20 inches in diameter each of the 128 pins would be about half an inch from its neighbor. When the pins for the sixteen wind directions have been properly weighted and the wheel has come to its position of equilibrium, which should be tested by several successive oscillations to the right and left, and when one has decided which of the pins is the lowest when the wheel has come to a rest, and which, therefore, indicates the resultant wind direction, he is to select the pin diametrically opposite to this resultant, and load it with additional weights until the wheel is neutral in all positions. But even in this simplified form it may be doubted whether the mechanism is any better than properly arranged forms of numerical computation.

*The variability of the wind is, strictly speaking, shown only by the relative number of the times that each direction of the wind occurs. If the wind has blown from all possible directions, then the resultant velocity is generally much smaller than when the wind blows steadily from one direction, therefore, the strength of the resultant is, in a rough way, indicative of the variability or the degree to which opposing winds have neutralized each other.—C. A.

THE METEOROLOGICAL STATIONS OF HARVARD UNIVERSITY.

The annual report for October, 1896, to September, 1897, inclusive, of Prof. Edward C. Pickering, as director of the astronomical observatory of Harvard College, shows his high appreciation of the importance of meteorology in connection with astronomy. The atmosphere by its refraction alters the apparent position of the stars; by the irregular refractions, due to the want of perfect homogeneity, the atmosphere introduces the blurred images and the rapid oscillations that prevent perfect steadiness of vision and cause the so-called "poor seeing;" by its dispersive power the atmosphere, acting like a prism, gives confusing colors and distorted outlines to the images of the stars and planets; by its general absorption the atmosphere renders the faintest stars invisible, and even the brightest stars may become invisible near the horizon; by its selective absorption the atmosphere introduces its own lines into the spectrum of the sunlight. The search after good seeing and the study of the brightness, or the variations in brightness of the variable stars, have led Professor Pickering to investigate the atmosphere of the Southern Hemisphere, in which work he was encouraged by the late Uriah Boyden, who left a large fund for astronomical research. An astronomical station is maintained at the city of Arequipa, Peru, and in connection with it the following "Boyden" meteorological stations:

Mejia (elevation 55 feet); La Joya (4,141); Arequipa (8,050); Alto de los Huesos (13,400); Mont Blanc station on El Misti (15,700); El Misti (19,200), and Cuzco (11,378).*

*An article by Mr. R. DeC. Ward in Science for January 21, 1898, adds a new station, Echarati, 130 miles north of Cuzco, latitude, 13° 31′ S.; longitude, 74° 24′ W.; elevation, 11,378 feet. The elevations of the instruments given in the above text have been corrected to agree with this recent article by Mr. Ward, to which we must refer the reader for many interesting details.